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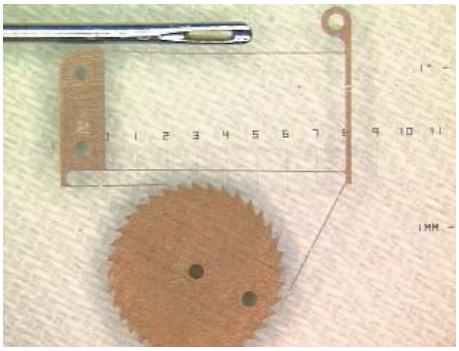
Agie Wire Micro-EDM Providing Answers To Meso-Machining Needs

The Mechanical Engineering department's meso-machining processes have become an important addition to Sandia's micro-machining capabilities, such as silicon surface micro-machining and LIGA.

Meso-machining represents a suite of subtractive machining technologies used to fabricate millimeter size parts having micron-size features (meso-scale) in a great variety of materials. The Agie wire micro Electro Discharge Machine (micro-EDM) has gained acceptance for fabricating meso-scale parts in conductive materials such as stainless steel, neodymium iron boron, and beryllium copper.

The wire micro-EDM process machines conductive material through a spark erosion process by placing a voltage potential between a 25 micron diameter wire and the work piece separated by a dielectric fluid. Gears having 175 micron tall teeth and flexures having a width of 50 microns have been fabricated by micro-EDM to tolerances of plus or minus 3 microns. Meso scale parts are slightly larger than silicon based micro machines (MEMS) but smaller than those created with typical miniature machining. The micro-EDM process is very competitive from a time and cost standpoint. Sandia has a need to fabricate micro and meso-scale parts for nuclear weapon and homeland security applications.



Stainless steel 4 bar flexure mechanism incorporating a drive and a hold pawl for actuating a ratchet gear. Flexure feature size is 50 microns with a tolerance of plus/minus 3 microns.

The Agie wire micro-EDM is a computer numerical control machine. Solid models of the part are used to create the tool paths defined in the program that drives the machine. Rough cuts and multiple finish cuts can be programmed to deliver surface finishes of 0.2 microns or better. Often sheets of material are stacked to yield multiple identical parts. High aspect ratio parts having micron size feature can be machined from material that is 1 millimeter thick.

Gil Benavides was the team leader.

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Gil Herrera Appointed Director of Mfg S&T Center

Visionary, networker, educator, salesperson, helmsman, cheerleader and, on occasion, obstacle-clearer—these are the roles Gil Herrera, the Mfg S&T Center's new director, sees himself playing.

An Albuquerque native, Herrera attended West Point and earned engineering degrees from UNM and UC Berkeley. He is a 20+-year Sandia employee, with a few years away as chief operating officer of SEMI/SEMATECH, a consortium of semiconductor suppliers that helped the nation regain prominence in semiconductor technology, and a year away serving as a White House Science Fellow on the staff of President George H. Bush.

In accepting the position Herrera said that he considered three factors. "The first was work that makes a difference to the nation, that truly serves the nation," he related. "The second was personnel who are extremely competent in the execution of their duties, so we can, as a management team, focus on growing the organization." The third was a question to himself: "What can I do for the organization? I value people who are not like myself, but rather people who are diverse. It's not the specifics of technologies nor infrastructures that make an organization outstanding; it's an outstanding management team that works together, especially when the work is closely coupled with national security."

Herrera hopes to meet with everyone in the Center and learn more about what makes the Mfg S&T organization so strong. "I'm taking a humble approach, listening and learning about how we are meeting the needs of our customer base so well. I'm concerned with people's interests; I want to know and trust their sense of execution of their work. I'm not a micro-manager; I need to comprehend the 'macro' aspects of our role within the Laboratories.

Gil Herrera

"I want to establish a course for the Center, but realize that I am only the

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Tech Updates

PZT Supply Team Goes from Basic Research to WR Production

The Ceramics and Glass Processing Department has had many successful interactions with the Material and Process Sciences and the Energy Components and Metrology departments over the years. To take a component concept from a series of drawings to the production floor requires design, basic and applied research and development, engineering, and manufacturing to work together effectively. Perhaps none exemplifies better the value of these relationships than the PZT Supply Team (PST).

In 1996 it was learned that the existing supply of PZT used to manufacture voltage bars for ferroelectric neutron generators would be exhausted sooner than anticipated. A program was initiated to develop a complete manufacturing process from the synthesis of the ceramic powder through the production and acceptance of War Reserve (WR) voltage bars. The collaboration among Manufacturing Science and Technology, Energy Components and Metrology, as well as various departments within the Materials and Process Sciences Center has been maintained throughout the program. Although the program emphasis has progressed from a basic research focus to a manufacturing focus, all program phases have benefited from this continuous collaboration. The basic research was influenced and shaped by design, scale-up, manufacturing, and environmental safety and health issues. Similarly, solutions to pre-production problems and process optimization depend in large part on continuing to develop a greater fundamental understanding of the material and the engineering processes.

Today, as the start of the first production lot is scheduled for Spring 2004, this collaboration continues as strongly as it did when the program began seven years ago. Although the PST anticipates delivering WR voltage bars on schedule, much work remains to improve the robustness of the manufacturing processes and to better understand voltage bar failure mechanisms (e.g., high voltage breakdown and voltage output). To build on these successes will require the continued synergy of design, research, development, and engineering.

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National Ignition Facility Collaborates with Sandia's Mfg S&T

The Thin Film Vacuum and Packaging department recently completed its engineering responsibilities for the National Ignition Facility (NIF). The NIF is a $3.6B laser fusion facility located at Lawrence Livermore National Laboratory. The NIF is a multi-lab DOE capital asset construction project that will be completed in 2008.

In 1996, as a result of the department's extensive experience and success in vacuum technologies, including the design and fabrication of vacuum systems, Woody Weed was recruited by the Pulse Power Sciences Center to engineer the vacuum pumping system for the NIF target chamber. Over the past seven years this critical system was designed, constructed and commissioned. Designers from the Sandia Design Group were added to the collaboration to provide CAD solid models and drawings.

The vacuum system evacuates the 33-foot diameter, spherical target chamber to 10^{-7} Torr to create an environment for laser fusion experiments. Four of the 192 laser beams are fully functional and initial experiments are underway.

The mechanical layout of the system was designed using solid model CAD tools. The vacuum system was integrated into the facility with an emphasis on avoiding mechanical interferences with laser systems. Performance was analyzed

NIF is about the size of a football stadium

using rarified gas flow simulation codes to optimize evacuation time and select piping diameters. The pumping system consists of a 6,000 liter/s oil free roughing system and four 90,000 liter/s cryogenic high vacuum pumps. Pressure in the 500,000 liter target chamber is reduced from atmospheric pressure to 10^{-5} Torr in less than one hour allowing rapid turnaround of experiments.

Cleanliness is critical to laser performance and target experiments. Contamination can destroy optics and degrade target diagnostic measurements. System components were specified to perform at cleanliness levels exceeding semiconductor manufacturing norms. Pump and valve suppliers stretched their engineering capabilities to produce qualified equipment.

The 33-foot diameter target chamber

The service life of the vacuum system is 30 years. Construction and commissioning tests were completed in June. The system is one of the largest vacuum pumping systems in the world and will provide an environment for the first laser fusion reactions later this decade.

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MESA TOP (Technology and Operations Prototype) and Mfg S&T

The Mfg S&T Center will be playing a key role in the emerging MESA TOP initiative. This program evolved as an innovative way to support the Weapons Integration Facility (WIF), which is part of the overall MESA program and is expected to be completed in 2009 or sooner. MESA TOP will be located in the Emcore building, which is part of the Technology Park located adjacent to the Laboratory. Occupancy is expected in August 2003

Bob Poole has represented the Center on a Management Team, which has worked to define the Management Process and the Operating Principles of MESA TOP.

The Goals of the MESA TOP initiative are summarized as:

- Defining a new way of accomplishing work by co-locating key staff in a classified-capable office and lab space for design, analysis, system integration and packaging activities for MEMS. The synergistic processes and lessons developed will help shape the occupancy of the future MESA complex.
- Create a work-unit/team that has transparent organizational boundaries
- Accelerate the design to product cycle time while keeping costs as low as possible

The mission of MESA TOP is to enable the successful insertion of a compelling microsystem(s) into a near term (3-5 year) nuclear weapon Life Extension Program and a conventional weapon program.

The Center's involvement is important to maintaining and contributing technically and programmatically to the MESA initiative. Gil Benavides and Tom Mayer will have offices in MESA TOP on a full time basis. Ken Peterson and Bob Poole will have part-time offices at the facility. Further Center involvement will be determined as the program evolves over the next few years.

The Emcore building at Sandia Science And Technology Park

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PITS Supports Electronic Fabrication Project Management

Beginning in January, the Electronic Fabrication Department has been piloting a new computer application: Project Internal Tracking System (PITS). PITS is a homegrown database jointly designed by department personnel with a team of information analysts and programmers (Bill Hughes, Tony Saba and Lynn Wilson). PITS supports the management of Service Orders for work performed for customers.

Before PITS, the department used the enterprise-wide Oracle Financial system to formally track its customers' projects. But the Oracle system primarily focuses on inter-organizational project information. Its main purpose is to track the actual cost of projects and facilitate the appropriate transfer of funds from customer organizations to the Mfg S&T Center.

The Oracle system did not provide the level of detail, timeliness nor functionality to effectively support the internal management of Service Orders. Consequently, department management and project leaders attempted to employ various informal, manual systems to internally manage the organization's projects. Despite great labor, these manual efforts led to problems such as under-billings and the inability for supervisors to track Service Order progress or to back each other up.

PITS replaces these ad hoc measures with one WEB-based application that supplements Oracle Financials. PITS allows supervisors to subdivide Service Orders into smaller assignments, such as specific definitions of work for a particular trade. Each assignment has its own budgeted cost and schedule. The tradespersons know what work is to be done, how many labor hours are budgeted, and when the work must be completed. Also, PITS allows for the daily reporting of labor hours so that actual cost can be tracked in a more timely manner. Since the project leaders are all using the same database, they can ascertain the status of all active Service Orders and cover for other project leaders when they are out of the office.

The next immediate step for PITS is to replace its paper traveler. The requirements for this enhancement have been defined and should be deployed this summer. Following that, the information team will be looking at the feasibility to use PITS as a front-end to Oracle Financials. This would eliminate the double-entry of data and ensure the synchronization of Service Order information.

Once this is achieved for the Electronic Fabrication department, the information team will be ready to work with other Center departments to determine if PITS can improve their Service Order management process.

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Precision Mechanical Measurements Laboratory

The Mechanical Measurements Team of the Manufacturing Processes & Services Department in Building 840 will soon have a new precision metrology laboratory located just north of the Mechanical Measurements office area (room 105). Construction work is underway (at right).

The room is being prepared to receive a prefabricated eleven-foot ceiling height metrology lab. The lab will have a full-laminar-flow ceiling with a temperature control of 20 C +/- 0.1C and relative humidity of 35% +/-3 %. This lab will significantly improve measurement equipment accuracy and provide for a more efficient laboratory layout and improved operations.

The project funding comes from the Nuclear Weapons Infrastructure Program. The estimated completion date is spring 2004. The Mechanical Measurements Team is eagerly anticipating the completion of this new lab and will remain open and operational throughout construction with minimal interruption to business.

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2002 DOE/NNSA Weapons Awards of Excellence

Elegant Solution to the Persistant NG Current Stack Hot Pole Cracking Problem

This award was given to several individuals for their participation in resolving the neutron generator current stack hot pole cracking problem. By doing so, this data shows a production yield improvement from 68% to greater than 95%, which significantly reduces production costs ~$40K/lot or >$160K/year, and minimizes the potential for missing the delivery schedule. The individuals included Pin Yang—Team Leader, Michael J. Hutchinson, George R. Burns, and Roger H. Moore. Other team members external to Mfg S&T included Steven N. Burchett, John H. Gieske, S. Jill Glass, Mark A. Rodriguez, Timothy W. Scofield, Mark E. Stavig, and Chad S. Watson.

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Green Zia Award

The Mfg S&T Center received Green Zia Achievement recognition for the 2003 Green Zia Program year.

Pollution Prevention

The Center has implemented several pollution prevention (P^2) initiatives relating to waste reduction goals for the Machine Shop. Over the last seven years, the Machine Shop has achieved a 35% reduction in waste generation. Chemical tracking and waste minimization initiatives have reduced the number of chemicals and cleaning solvents by 50%. Coolant recycling shows a 50% reduction and additional coolant recycling efforts are projected to reduce waste generation by an estimated 30%.

Successful Approaches

New successes are being planned. The Green Zia team will be applying Green Zia tools to other processes in the Center. The tools help organizations evaluate processes to reduce waste and resource use. An energy reduction initiative, already underway, is projected to save about 15 to 20% of energy costs immediately with an additional savings of 10 to 15% over the next several years. Plating processes are being evaluated to determine if bath sizes can be reduced thereby reducing waste generation. The use of chlorinated solvents is also being re-evaluated to determine if less hazardous chemicals can be substituted.

Results

Mfg S&T projects a savings of about 15 to 20% in energy costs immediately with an additional savings of 10 to 15% over the next several years by implementing an energy reduction initiative.

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Active Brazing Revolutionizes Ceramic to Metal Joints in Neutron Tubes

Active brazing methods allow ceramics to be joined directly to metals. The active braze process eliminates the need for metallization-related processes, saving considerable costs and time. This is the first time that this process is being used in a neutron tube in the U.S. Active brazes are made using braze filler metals that have a small addition of a metal that is a strong oxide former (usually a group IVA element: Ti, Zr or Hf).

Although it seems like a minor change, the joint designs, clearances, tolerances and tube performance are all affected when the design changes from a conventional to active braze. In addition to the brazing personnel, the team includes representatives from the material sciences, metallurgical, finite element analysis, neutron tube design, prototyping and production groups.

Chuck Walker was a member of the Active Braze implementation team. Other members included Keith Meredith, John Brainard, Steve Burchett, Carla Busick, Evan Dudley, Gregory Neugebauer, Matthew Senkow, and John J. Stephens, Jr.

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Distinguished Members of the Technical Staff (DMTS)

David Adams and Pin Yang were recently promoted to DMTS level.

David's expertise includes thin films and their properties, surface physics, micro fabrication, focused ion beams, materials science, and engineering and manufacturing technologies.

David Adams

Pin's expertise is in the electrical property characterization of ceramic materials as well has his comprehensive knowledge of general ceramic processing and characterization, active ceramic component production, ceramic thick film deposition, photovoltaic materials and laser interactions with ceramic/glass materials.

Pin Yang

These appointments recognize individuals for their exceptional contributions to the success of Division 14000, the Mfg S&T Center, and Sandia National Laboratories.

Gil Herrera, continued from page 1

helmsman of something like an aircraft carrier already at speed. I hope I can make the course smoother, with less bumps. I want to worry about the future, while our managers execute the present."

Herrera sees changes for the Center, as Sandia faces a future where nuclear weapons may not be as widely supported as a strategic deterrence as in the past. The NNSA budget has increased more than $400M in the last five years, but this current path is seen as unsustainable, and a transition will occur in the next 10 years.

"Mfg S&T needs to evolve to meet the challenges of a more balanced portfolio. The nuclear weapons part of our business requires specialized capabilities that can be developed and sustained only here. In a way, it's almost a captive business. Other customers such as the Department of Defense, other federal agencies, and industry, are not captive. As our nation's view of national security changes, we need to establish a broader vision. We need to know who our new customers are, what are their needs, and how we build the financial systems and infrastructures to accommodate them."

In working to help Sandia achieve a more balanced portfolio, Herrera envisions two main thrusts, one internal, based on Mfg S&T's established strengths; the other a partnership with Sandia's other Strategic Management Units (SMUs).

"Internally, I see some structure changes—not big changes, but studying and implementing changes to do our work better, and to improve quality, safety, and our environmental responsiveness." He cited the Center's thrust toward ISO 9000 standards as an example. "We want to lower our costs to the customer while increasing our quality. I've been very impressed by what I've seen so far. Now we need to tailor our work toward different customers to provide a better product for less cost."

In doing work for other Sandia SMUs, Herrera sees "an established mutual respect. They know our capabilities. We must further define their needs that we can meet. Still, it is evolving in a positive way. We need to educate the rest of Sandia about our successes, and connect with them to achieve the vision of a national security lab."

—Peter Nolan

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